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Indian Standard

SAFETY REQUIREMENTS FOR ELECTRO-SLAG REMELTING FURNACES

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SAFETY REQUIREMENTS FOR ELECTRO-SLAG REMELTING FURNACES

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SAFETY REQUIREMENTS FOR ELECTRO-SLAG REMELTING FURNACES

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 26 June 1986, after the draft finalized by the Industrial Electroheating Equipment Sectional Committee, had been approved by the Electrotechnical Division Council.

0.2 This standard has been formulated with a view to specify the safety requirements for electroheating installations for the remelting of metals through direct resistance heating of a conductive slag.

0.3 The general requirements for safety in electroheat installations are covered in IS : 9080 (Part 1)-1979*. The requirements of this standard shall be read in conjunction with and in addition to the general requirements covered in IS : 9080 (Part 1)-1979*.

0.4 In preparing this standard, assistance has been derived from IEC Document 27 (Central Office) 59 'Safety requirements for electro-slag remelting furnaces', issued by International Electrotechnical Commission.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960†. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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1. SCOPE

1.1 This standard covers the safety requirements for electroheating installations for the remelting of metals through direct resistance heating of a conductive slag.

*Safety requirements in electro-heat installations: Part 1 General requirements.
†Rules for rounding off numerical values (*revised*).

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions given in IS : 1885 (Part 51/Sec 1 and 2)-1979* shall apply.

3. ELECTRICAL EQUIPEMENT

3.1 High Voltage

3.1.1 *General Characteristics* — Electrical equipment shall be designed and built in order to meet the following requirements to ensure adequate safety in operation:

a) The supply system shall be designed to withstand sudden current fluctuations occurring at the start of the melting process with dry slag,

b) The switch shall be designed for frequent operation, and

c) The secondary circuit shall be earthed directly or through an approved earthing device.

3.1.2 *High Voltage Switching on Conditions* — The following shall be verified before the high voltage switching on:

a) Isolator in closed position,

b) Minimum secondary voltage selected, and

c) Furnace conditions for operation are met.

NOTE — It is desirable that provision be made for a luminous or other signal indicating that switch-on conditions are satisfied and that the switch-on can take place.

3.2 Power Circuit — This circuit shall include an earthing connection preferably at the base plate which supports the ingot. If the installation enables several melting stations to be supplied from the same power supply, each station should be provided with an earth connection.

The circuit of the melting station which is not working shall be isolated from any circuit in operation, not on the earthed side.

3.2.1 The following conditions shall be satisfied by the power circuit when switching on:

a) Melting station change-over switches in closed position. The station in operation shall be indicated on the control board,

b) Electrode and ingot mould aligned in melting position,

*Electrotechnical vocabulary: Part 51 Industrial electro-heating,
Section 1 General terms; and
Section 2 Resistance heating.

c) Base plate in operating position,

d) Removable contact-making devices in closed position; in particular electrode clamps or contact shoes, either closed with minimum pressure if a hydraulic or pneumatic system is used or locked if the system is mechanically operated. The same requirement shall be met by the clamping of the ingot base plate, and

e) Connections of cooling circuit, if provided, in working order (flow pressure, temperature).

3.3 Auxiliary Low-voltage Circuits

3.3.1 *Control Station* — The following indications and controls should be grouped in the control room:

a) Flow indication of ingot mould cooling ciruit,

b) Secondary current and voltage measurement,

c) Control of movements likely to occur during melting (furnace on-load),

d) Setting of desired operating values,

e) Alarms associated with furnace, and

f) Emergency stop switch.

3.3.1.1 The control station should be so located that the furnace can be well seen.

3.3.2 *Emergency Stop Switch* — It shall cause:

a) automatic raising of the electrode(s) by a distance sufficient to clear the slag; and

b) disconnection of furnace of power supply.

3.3.2.1 It shall not cause stopping of pumps or closing of cooling circuit.

4. MECHANICAL PART

4.1 Hot Metal Ejection — The control station shall be completely protected against liquid metal ejected from the melting area.

4.2 Vibrations — Vibrations, in particular, those caused by sudden variations of the electric melting current shall not affect position of the ingot mould, ingot or electrode clamps.

4.3 Parasitic Heating — The electrical, mechanical and hydraulic equipment as well as the flexible connections of cooling circuits shall be protected against heat radiated directly from slag and electrode radiation and hot gas convection. They shall also be protected in particular against heating due to electromagnetic phenomena.

All metal parts which are subjected to high-intensity magnetic fields and are in contact with oil circuit sealing points or oil, shall be made of non-magnetic material and installed in such a way as to avoid closed loops.

4.4 Restriction of Access — Access to the supporting structure above and under the melting area shall be forbidden whenever the furnace is energized. Operators who have to service the working furnace (for example, temperature measuring, changing electrodes) near live or hot parts shall wear protecting clothing, gloves, footwear, visors (goggles), safety helmet, etc.

The electrode holder and lifting gear shall be designed to prevent the falling-down of electrodes.

The vertical moving parts have to be kept in position (or slowly moved down) in case of failure of the lifting device.

4.5 Electrode Position Control — All movements have to be limited and electrodes handled carefully.

5. COOLING CIRCUIT

5.1 Ingot Mould and Ingot Base Cooling — Special precautions have to be taken for the cooling of ingot mould and ingot base in the event of power failure.

5.2 Cooling System Controls — The following indication and measurements shall be provided:

a) monitoring of cooling water flow,

b) measurements of cooling water outlet temperature; and

c) optionally the measurement of cooling water inlet temperature.

The water flow and the temperature rise of each cooling circuit shall be separately monitored. Failure of cooling water flow shall disconnect the furnace power supply and automatically raise the electrodes to clear the slag.

5.3 Design — The following aspects shall be considered in the design of cooling circuit:

a) The supply of the cooling water shall be adequate to prevent an undue heating of the cooled wall;

b) Cast or welded ingot moulds shall be free from porosities, cracks, etc, which could have an injurious effect on water tightness and heat transfer; and

c) The use of seals likely to come into contact with molten materials shall be prohibited.

6. FUME EMISSION CONTROL

6.1 Slag melting furnace shall and ingot moulds shall be covered by a collecting system extracting the fumes from the working area.

7. GENERAL SAFETY

7.1 The melting area shall be provided with sufficient free exit to enable rapid evaculation in emergency.

7.2 Fire-proof clothing, fire-proof and electrically insulated gloves, footwear and tools, high temperature visors of size to cover face and neck and safety helmets shall be readily available local to the melting area. These shall include those required for both the setting up and melting phases.

7.3 Tools which may be used in contact with liquid metal or slag shall be cleaned and dried before use.

7.4 Gangways shall be marked out and shall be kept clear and clean. Adequate water drainage shall be provided.

7.5 Where molten slag starting procedures are used, precautions shall be taken to prevent accidental contact with molten slag. (The precautions should be appropriate to a temperature of 1 500°C.)

7.6 Pressure vessels and containers of liquids or gases shall not be located within the operational area surrounding the furnace and control station.

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	Unit	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	Unit	Symbol
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	Unit	Symbol	Definition
Force	newton	N	1 N = 1 $kg.m/s^2$
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2